ESRF	**Experiment title:** Low temperature phase transition in the CdYb icosahedral quasicrystal	**Experiment number**: HC1874
Beamline: BM01A	**Date of experiment**: from: 10/04/2015 to: 14/04/2015	**Date of report**: XX/MM/2016
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Report:

Quasicrystals are long range ordered materials that lack translational symmetry. Their structures are now well understood using the superspace formalism and a detailed understanding has been achieved for the icosahedral (i) $YbCd_{5.7}$ phase [1]. It has been shown that the i-$YbCd_{5.7}$ are built up with the Tsai-type icosahedral atomic cluster [2]. However the central cluster shell is a Cd_4 tetrahedron that breaks the icosahedral symmetry and plays a crucial role for the stability of the icosahedral phase.

Recently, a hysteresis anomaly on the electrical resistivity on i-$YbCd_{5.7}$ quasicrystal has been observed around 80 K. This facts implies a phase transition in the icosahedral phase at low-temperature, similar to an order-disorder type phase transition observed in the quasicrystalline approximant phases, which is attributed to the orientational ordering of the central tetrahedron at low-temperature [3-8]. A preliminary test by selected area electron diffraction shows a distortion of the high temperature icosahedral phase. However, x-ray diffraction experiment is necessary to evidence a structure phase transition at low-temperature.

Low-temperature single-crystal diffraction has been carried out on BM01A on the i-$YbCd_{5.7}$. A single domain crystal (approximately $100 \times 100 \times 100$ μm^3) was extracted from the i-$YbCd_{5.7}$ polygrain sample on which the hysteresis anomaly in the electrical resistivity between 60 and 80 K has been clearly confirmed. We have collected full datasets have been collected with several camera distances at from 22 K to room temperature.

Firstly, the diffraction images were collected at room temperature and then the sample was cooled with Helijet down to 20 K. However, we have found out that the sample was not cooled properly with the Helijet.

We thus changed to the N_2 jet and collected diffraction data between 80 K and 180 K. Figure 1 shows peak profiles of a Bragg reflection 1 -2 3 4 -4 0 for i-$YbCd_{5.7}$ between 90 K and 180 K. A peak broadening is clearly observed when the sample was cooled and it becomes sharper when the sample was heated up. The is also clear on the 2-D image. The reversible change in the peak profile was also confirmed for other Bragg reflections.

In order to distinguish whether it is related to phonon or phason, delta Q is plotted as a function of parallel and perpendicular components of Bragg reflections a 80 and 160 K (Figure 2). On Fig. 2 a linear dependence

is clear when plot as a function of Q_{par} , whereas it is not clear when plot as Q_{perp}. This result indicates that the observed peak change is related to phonon strain rather than phason strain.

In conclusion, we have obtained clear evidence for a reversible change in the peak profile for the i-$YbCd_{5.7}$ quasicrystal at low-temperature for the first time. This observation may be related to a pretransitional phenomenon of a structure phase transition in the icosahedral phase.

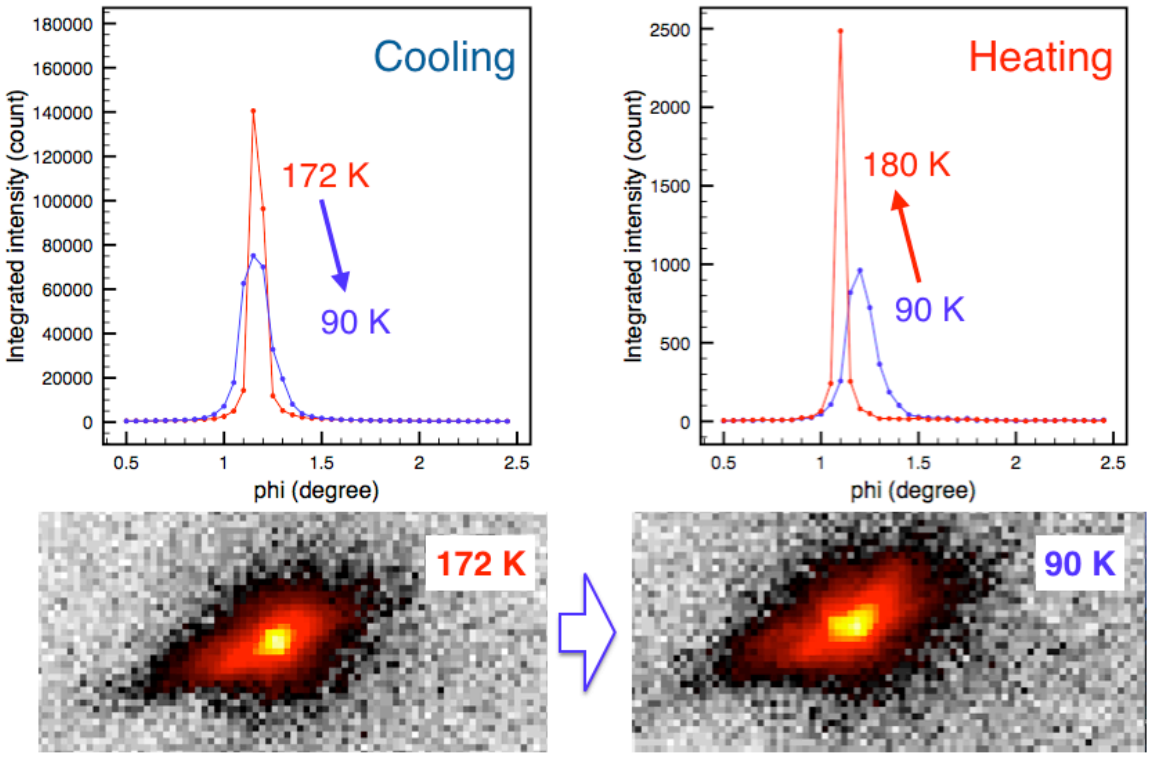

Figure 1; Peak profile of 1 -2 3 4 -4 0 Bragg reflection of the i-$YbCd_{5.7}$ quasicrystal during cooling and heating (top) and 2-D image of the peak at 172 K and 90 K.

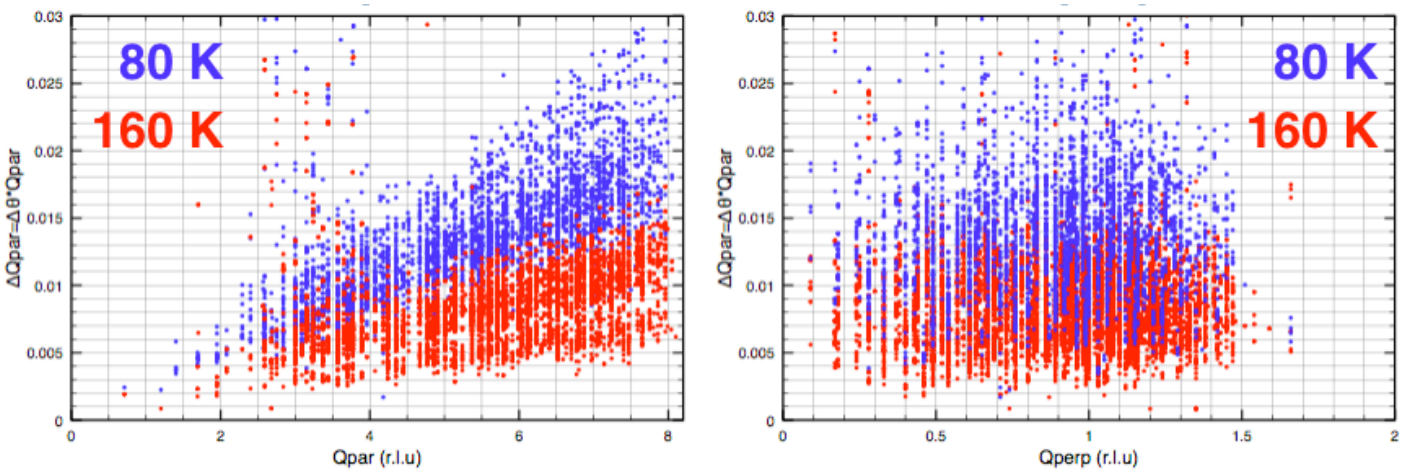

Figure 2; Delta Q as a function of (left) Q_{par} and (righ) Q_{perp} at 80 K and 160 K for the i-$YbCd_{5.7}$ quasicrystal.

References

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